Improved Across-Site Biomass Retrieval from P-band SAR Backscatter

Maciej J. Soja (soja@chalmers.se), Gustaf Sandberg, Lars M. H. Ulander
Chalmers University of Technology, 41296 Göteborg, Sweden

Low-frequency Synthetic Aperture Radar (SAR) has shown itself to be a good tool for forest biomass estimation. Especially at P-band, good sensitivity to large range of biomasses (over 300 tons/ha) can be observed which makes it suitable for global biomass mapping. However, no P-band satellite is available yet and thus most research has been limited to few airborne studies. Most of the studies were done using the same test site for training and evaluation of the algorithms. In this paper, biomass estimation from P-band SAR backscatter is evaluated using an across-site approach. In this approach, algorithms are trained and evaluated on two different sites situated at a great distance from each other, thus evaluating the extrapolation possibilities of the proposed models. This approach gives a better insight into the generality of the models.

The data used for this study have been acquired within two campaigns conducted by ESA in Sweden: BioSAR 2007 conducted in Remningstorp in the south-west of Sweden, and BioSAR 2008 conducted in Krycklan in the north-east of Sweden. The data have been acquired using the ESAR platform operated by the German Aerospace Center (DLR). For an extensive analysis of BioSAR 2007-data, see Sandberg et al [1].

First results show that HV-backscatter based models fail when used for extrapolation to different sites and/or weather conditions. The introduction of HH- and VV-backscatter, as described in Saatchi et al [2], reduces the weather influence but still does not improve the across-site retrieval. Also, the number of model parameters increases.

In this text, a new model with better performance than the established models is proposed. The model includes all three polarizations together with some topography corrections. Instead of letting HH and VV be independent from each other, the ratio between these values is fixed. Also, the model parameters are chosen to be functions of ground topography:

$$\log_{10} W = a_1(u,v) + a_2(u,v)[\gamma^0_{HV}]_{dB} + a_3(u,v)([\gamma^0_{VV}]_{dB} - [\gamma^0_{HH}]_{dB})$$

where

$$a_i(u,v) = a_{i0}(1 - \xi_i u)(1 + \eta_i \sin(v))$$

and the angles u and v are as defined in Ulander [3]. The proposed model gives much better across-site retrieval performance than any other algorithms presented in literature. Estimation errors of less than 45 tons/ha can be achieved with training and validation performed on two different test sites.

[1] G. Sandberg, L. M. H. Ulander, J. E. Fransson, J. Holmgren, T. Le Toan, " L- and P-band backscatter intensity for biomass retrieval in hemiboreal forest", Remote Sensing of Environment, in press.

[2] S. Saatchi, et al, "Estimation of Forest Fuel Load From Radar Remote Sensing", IEEE Transactions on Geoscience and Remote Sensing, vol. 45, no. 6, June 2007.

[3] L. M. H. Ulander, "Radiometric Slope Correction of Synthetic-Aperture Radar Images", IEEE Transactions on Geoscience and Remote Sensing, vol. 34, no. 5, September 1996.